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A Quarter Century Effort Yet to Come of Age: A Survey of Electricity Sector Reform in Developing Countries

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Abstract

More than two decades have passed since the start of the worldwide market-oriented electricity sector reforms. The reforms have varied in terms of structure, market mechanisms, and regulation. However, the passage of time call for taking stock of the performance of the reforms in developing countries. This paper surveys the empirical literature on electricity sector reforms and draws some conclusions with a view to the future. Overall, the reforms have tended to improve the technical efficiency of the sector. The macroeconomic benefits of reforms are less clear and remain difficult to identify. Also, the gains from the reforms have often not trickled down to consumers because of institutional and regulatory weaknesses. In order to achieve lasting benefits, reforms need to adopt measures to align their pursuit of efficiency and economic with those of equity and provision of access. Reforms can deliver more economic benefits and alleviate poverty when the poor have access to electricity. New technologies and institutional capacity building can help improve the performance of reforms.

Keywords: Energy, reform, efficiency, poverty
JEL Classification: L52, L92, Q48

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1. INTRODUCTION

Since the early 1980s, and gathering pace in the 1990s, the network industries including the electricity sectors across the world have been subjected to restructuring and market-oriented reforms. By the end of the 1990s, the majority of OECD countries and over 70 developing and transition economies had taken some measures toward reforming their electricity sector (Bacon and Besant-Jones, 2001). The reforms aimed to replace the monopoly status of vertically integrated state-owned utilities and to allow private and foreign investors to take part in both the competitive and regulated part of the sector (Joskow, 1998; Newbery, 1999; Littlechild, 2000). The reforms remain work in progress in many developing countries offering the possibility to synthesize the lessons of experience to date.

A generic reform of the electricity supply industry (ESI) involves high level measures such as: corporatisation of the entities, unbundling and restructuring of the sector, introducing competition in wholesale generation and supply activities, horizontal separation of incumbents to create viable competition, establishing independent regulatory authority, and privatization (Besant-Jones, 2006; Jamasb, 2006). These measures would allow vertical separation of the natural monopoly networks (transmission and distribution) from the potentially competitive segments (generation and supply). Vertical separation would prevent cross-subsidization between the competitive and regulated businesses and discriminatory practices such as denial of third-party access to networks (Joskow, 2003). The degree of vertical separation varied and took the forms of functional, accounting, legal, or ownership separation. Low level reform measures include cost-reflective pricing (e.g., removal or restructuring of subsidies, tariff liberalisation and cost-reflective price setting), adoption of new technologies, new financial schemes and community involvement (Prasad, 2008).

In developing countries, the high and low level reforms were implemented against the backdrop of chronic electricity shortages, weak institutions, under-capitalisation, poor operating equipment, high system losses (and electricity theft), complex political economy settings and the inability to extend access to all the poor. The reforms were expected to enhance efficiency, improve quality of service, reduce the price-cost gap through cost-reflective pricing and increase investments (Newbery, 2002; Kessides, 2012). Reforms would also benefit the poor by improving access to electricity thereby enhancing other services such

as healthcare, education and communications, cost efficiency, and stimulation of economic development and welfare (Davies et al., 2003).

A key question is the extent to which these goals have been achieved in practice considering that ample resources have been invested in the reforms in nearly three decades. Answering this question requires revisiting the theoretical rationale and examining the empirical evidence of progress and performance of the reforms against their objectives. However, comprehensive analyses of the effects of the reforms on the sector and the economy (e.g., electricity pricing, quality of supply, utility performance, economic growth, social welfare and poverty reduction) are limited in the literature.

On the other hand, there has been a renewed interest in the relationship between electricity sector reforms, reliability and quality of service, economic growth, welfare, and the environment, particularly climate change concerns (Nepal and Jamasb, 2015). For example, the UK, a pioneer of market-based reforms, proposed a new electricity market reform in 2010 signalling the desire for more government intervention to meet its sustainability objectives (Pollitt, 2012). In Latin America, countries such as Bolivia, Venezuela and the Dominican Republic some assets have been renationalized indicating a return to an active role for the state in the sector (Balza et al., 2013). Argentina, once at the forefront of market oriented reform, has also diminished the role of markets in the energy sector (Littlechild, 2013).

Nearly 30 years since the first electricity sector reform in Chile, this paper takes stock of the cumulative experience with this important experiment in developing countries. The reforms have proven more difficult than first anticipated and most remain work in progress. This paper attempts to reduce the research gaps in the electricity reform literature by reviewing the progress and the outcomes. In an earlier study, Jamasb et al. (2005) reviewed the evidence from reforms in developing countries focussing on the operating efficiency and access. This paper differs in focus and aims to revisit and reflect on the reform experience as many developing countries are undergoing a period of introspection after more than quarter of a century of reforms. Electricity reform in developing countries is at a stage where a review is necessary considering the inconclusive verdict on the effectiveness of reforms purveyed by the existing literature.¹

We consider both empirical and theoretical literature on the linkages between electricity reforms; economic and technical efficiency, economic growth, welfare and poverty reduction

¹ We thank a reviewer for this point.

in developing countries. The paper aims to highlight reform performance, explore the link between the theory and practice of electricity reforms and thus fill an important gap in the literature. We do not examine the impact of reforms on the environment. It suffices to state that reforms may or may not have negative environmental impacts as this is rather a matter of devising effective environmental policies.²

The remainder of this paper is structured as follows. Section 2 provides an overview on the drives, context and status of electricity reforms around the world. Section 3 discusses the different methodological approaches to studying the impacts of reforms and analyse the impacts of energy sector reforms on several industry specific and macroeconomic dimensions. Section 4 synthesizes the insights from the reforms and policy lessons while critically reflecting on the development of the reforms. Section 5 concludes the paper.

2. ELECTRICITY REFORMS: CONTEXT, DRIVERS, AND STATUS

Adopting market-oriented electricity sector reforms based on the ‘textbook or standard model’ became a world-wide trend during the 1990s. The textbook model was first applied in the Chile in 1982 and inspired reforms in other countries. The standard model involved the following steps and sequence: i) corporatization of state-owned enterprises and creating state-owned corporations, ii) enacting legislation for sector liberalization, iii) establishment of an independent regulator, iv) unbundling (vertical separation) of the main functions, v) incentive regulation of the networks, vi) establishment of wholesale and retail electricity markets, vii) privatization through sale of assets from the state to the private sector³ and introduction of private independent power producers (IPPs). The model represented a paradigm shift in terms of electricity sector structure, the role of the state, and the regulation of the sector (Joskow, 1998; Newbery, 1999; Joskow, 2008).

Market structure exerts strong influence on whether and the extent to which reforms can improve the efficiency and performance of the sector. Creating a market-based structure

² A notable study by ESMAP (2011) shows that vertical unbundling tends to reduce carbon dioxide emissions by 5% indicating a higher degree of environmental sustainability.

³ Corporatization involves reorganizing the structure of the government-owned entity into a legal entity with a corporate structure still allowing the government to retain ownership of the company while privatization is the transfer of government-owned assets and rights into private hands. Corporatization is normally a precursor to partial or full privatization in many cases.

required ownership unbundling and workable competition in the generation and supply functions (Newbery, 2005). Competition inevitably meant a reduction in state ownership, as new private actors could participate in wholesale markets and erode market shares of the incumbents (Pollitt, 2012). The reforms aimed at expanding the scope for competition in the sector through ‘*competition in the market*’ or ‘*competition for the market*’. As a result, there was a strong drive for privatisation and new models of private sector participation such as Public-Private Partnerships (PPPs) in the sector (Ljung, 2007; Vagliasindi, 2013).

The reforms also revealed the need to create strong and effective new institutions in the form of independent regulatory agencies. The separation of the natural monopoly networks from the competitive segments and privatisation placed much emphasis on economic regulation to ensure that public interests were reflected in terms of service quality, network access and tariffs while the generators had equal access to the grid and consumers. Incentive regulation of networks was a practical approach where competitive markets could not exist (Vogelsang, 2002). The perverse incentives created by cost-of-service regulation in the form of gold-plated assets (Averch and Johnson, 1962) implied that incentive regulation could be adopted to improve cost efficiency of the transmission and distribution networks.

Table 1 contrasts the drivers of electricity reforms in developed and developing countries. The motives for reforms differed in developing and developed countries while external drivers played a key role in shaping the reforms. Poor operational and financial performance of state owned utilities; technological progress and development of the efficient combined cycle gas turbines (CCGTs); political faith in the markets, competition and privatization; pressure from international donor organisations; proceeds from asset divestiture and reducing Public Sector Borrowing Requirement (PSBR) were among the drivers of the reforms.⁴ The pre-reform sectors in developing countries were primarily characterised by: i) poor performance of the state-run utilities in terms of high costs; ii) inadequate expansion of

⁴ For example, the World Bank changed its lending policy in 1992 followed later by the Asian Development Bank (ADB); the European Bank for Reconstruction and Development (EBRD) and the Inter-American Development Bank (IADB) for electricity development from the traditional project lending to policy lending. Almost \$US 187 billion of private capital flowed into the economies of 76 developing countries during the 1990s (Beder, 2005). In the UK, privatization of state-owned energy utilities reflected the ideology of the government and its interest in reducing the cost of domestic coal subsidies and strong economic and political motives also existed in Chile, Norway and New Zealand (Newbery, 2002; Hogan, 2002). Technological progress lowered the significant barriers to entry and competition that existed in power generation. Likewise, Bolivia including other Latin American countries (LACs), Ghana and the transition economies (which include the countries in the former Soviet Union) are examples of energy sector privatization in the context of debt crisis. Interestingly, privatisation in the LACs contributed to about 40% of the total value of energy privatizations in the world during the 1990s (Gabriele, 2004).

access to service for the population, coupled with unreliable supply; iii) the inability of the public sector to finance the needed spending on new and maintenance investments; iv) the need to remove subsidies in order to release resources for other essential public spending needs and v) the need to raise revenue for cash-strapped governments through the sale of assets (Bacon, 1995; Bacon and Besant-Jones, 2001; Joskow, 2008).

Table 1: Drivers of Electricity Sector Reforms

| Electricity sector drivers | External drivers |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><i>Developed countries:</i> Excess capacity, use of costly generation technologies, economic inefficiency, and growing consumer demand for cheap energy.</p> <p><i>Developing countries:</i> Lack of public sector financial resources to meet growing demand, institutional inefficiency, burden of energy subsidies, low service quality, high energy losses, poor service coverage, capacity shortage and energy sector investment constraints.</p> | <ul style="list-style-type: none"> a) <i>Political and economic ideology:</i> Based on the forces of market, competition and privatization. b) <i>Technological innovation:</i> Such as the development of CCGTs. c) <i>Macroeconomic events:</i> Such as the post-Soviet economic transition (1989), Latin American debt crisis (1980s), Asian financial crisis (1997-1998). d) <i>Capital raising options:</i> Privatization of state owned energy assets. e) <i>OECD energy deregulation:</i> Creation of new energy multinationals looking for new investment opportunities. f) <i>Lending policies of donors:</i> Such as those of the World Bank and IMF with strings attached. g) <i>National economic reform context:</i> As a result of economic crisis and structural adjustment programs. |

The initial conditions such as resource endowment, initial structure, size, and institutional strength of the electricity sectors as well as the design, scope, and implementation of reforms varied across countries. These factors inevitably came to play an important role in adoption and performance of the reforms influencing the design and pace of reforms (World Bank, 2004). The *initial sector structure* defines the starting point of the reform process and is important for envisaging an appropriate structure from the start of the reform process and realising the benefits of reform, which may be substantial (Hogan, 2002). The *institutional factors* refer to the sector and economy level legal and regulatory framework that influence and support continuity of the reform process. The reforms and regulation of the sector in

developing countries tend to suffer from weak institutional environment in terms of limited regulatory capacity, limited accountability, limited commitment and limited fiscal efficiency (Laffont, 2005). A weak institutional environment can render the reforms and regulation of the sector ineffective. Hence, effective regulation remains a challenge in developing countries considering that regulators struggle to determine whether and how to introduce competition in the network industries (Armstrong and Sappington, 2006).

Regulation (predominantly cost-based) can also be prone to political capture and becoming a tool of self-interest for the government or the elite in developing countries (Stiglitz, 1998). However, regulation by contract or in combination with regulatory independence can provide a better regulatory framework for developing countries aiming to privatize their systems (Bakovic et al., 2003). The *size of the sector* can influence the reform capabilities and options of the reforming countries. It is not clear if small electricity systems in developing countries require or benefit from vertical separation and third-party access. For example, the scope for competition may be limited implying that, in small systems; the benefits of liberalization may be small in relation to the costs (Kessides, 2004).

Despite these notable differences, the reforms have been pursued across the world under varying initial conditions. Some have had relative success while many have not lived up to ambitions and expectations after more than two decades of reforms. For example, market driven reforms in OECD countries such as Chile, Norway have performed well as in the UK, often considered as a successful model of electricity reforms (Joskow, 1997; Newbery and Pollitt, 1997; Jamasb and Pollitt, 2005).⁵ In contrast, the inability to attract private investments in Sub-Saharan African countries such as Uganda and Zambia remains a disappointment. According to the World Bank's Private Participation in Infrastructure database, there was a boom in IPPs during the 1990s, which subsequently abated with the arrival of the financial crisis in the late 1990s.

Reforms seem to have failed to correct the chronic underinvestment in electricity supply in most developing and transition countries, which accounts for much of the poor performance of the sector in these countries. For example, there was little investment in the sector from 1991 to at least the mid-2000s except for the Russian Federation and Turkey in the European and Central Asian countries (Barbara, 2010). Some countries (e.g. in Latin America) have

⁵ Examining the empirical literature and evidence on the impacts of reforms in developed countries is outside the scope of the present paper.

made relatively advanced transition to market-based energy sectors while others (e.g., China, Russia, South Africa) are caught between the state and the market where the state still plays a dominant role in operation and management of the sector. Table 2 summarizes the electricity reform experience in a matrix for selected cases.

Table 2: Reform Status of Electricity Sector in Selected Countries

| Country | Primary factors for reform | Milestones of reform process | Main outcomes | Limitation/ challenges |
|----------------|---------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Brazil | Poor performance of state-owned utilities, demonstrations effects from Chile and Argentina. | Launched radical reforms in 1996, privatisation began in 1995, creation of independent regulators in 1998, short term wholesale market created between 1995 and 2003, long term contracts model replaced the previous wholesale market between 2004 and 2005. | Increasing reversal to central planning, competition has improved in the sector, auction process in transmission provide competition and incentives for investors, and distribution companies procure electricity at competitive price. | Excessive reliance on hydropower can lead to energy crisis in the face of rising demand as in 2001-2002, de-carbonisation a challenge when addressing security of supply and fuel diversity in generation, attracting private investments a necessary condition for the growth of the sector. |
| China | Electricity reforms pursued as a part of wider liberal economic reforms. | Corporatisation and commercialisation of sector in 1998, 1999 bidding by power generators, separation of generation from transmission and distribution in 2002, creation of state electricity regulatory commission in 2002, scheme for power price reform in 2003. | Overall reforms postponed, industry restructuring not accompanied by the introduction of competitive markets, entrenched interests have obstructed further reform, generating capacity doubled between 2002 and 2007. | Future of power sector reform uncertain, political environment will be important in moving forward with stalled reforms, institutions such as legal system and capital markets remain immature to support competitive markets. |
| Fiji | Fiscal problems, donors lending policy. | 1996 Public Enterprise Act, functional separation in 1998, internal reform again started in 2002, tariffs increase by independent regulator in 2005. | Productivity improvements, system losses reduced from 18% to 10%, tariff collection rates increased, more authority and discretion to independent regulators. | Regulator unable to make independent decisions on tariff setting, unstable political environment can lead to low private sector involvement. |

| | | | | |
|--------|----------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ghana | Supply shortages, external lending policy, fiscal crisis, lack of investment, poorly performing distribution sector. | World Bank requires reform as loan conditions in 1994, 1997 restructuring and privatization plan, regulator formed, IPPs introduced in 1998, reforms shelved by parliament in 2001, Volta River Authority (VRA) unbundled in 2008. | Reforms stalled, structure of the sector has not changed much, VRA mostly operating under financial losses, distribution losses remain high, tariff setting not economic and eroding the long term viability of utilities. | Regulator not independent from political interference, no standard form of PPA in the market, competing pressures to keep consumer tariffs low hampering the establishment of cost-reflective tariff. |
| India | Economic openness to foreign investment, poor performance of state-owned electric utilities. | IPP entry in 1991, introduction of independent regulation act (at state level) was passed in 1998, Electricity Reform Act enacted in 2003. | All states (29) have constituted independent regulators while 23 states have undertaken tariff reform, 20 states have implemented unbundling/corporatization, 2 states (Orissa and Delhi) have privatised distribution, 28 states have implemented third party access and 11 states have exercised multi-year distribution tariff orders. | Success of reform not encouraging, questionable outcomes based on competition and privatisation, technical losses above 35% of power generation, power theft on-going, state-level corruption, and subsidised tariffs. |
| Russia | Electricity reforms pursued as a part of wider liberal economic reforms after Soviet-Union break up. | Establishment of joint stock company for electricity in 1992, reform principles adopted in 2001, regulatory framework established in 2003, gradual transition towards market pricing in 2003, privatisation of quasi-monopolist in 2008, free market pricing in theory in 2011. | Reforms stalled, lack of insufficient investments for system modernization and low carbon generation capacity, electricity pricing controlled by government for social equity concerns. | Blackouts in 2002 highlighted fragility of the system, destruction of a hydropower plant in 2008 highlighted the need for system modernisation, market pricing only in theory as government actively monitors electricity prices. |

| | | | | |
|--------------|-------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| South Africa | Democratic revolution of 1994, poor performance of state-owned utilities, new international thinking. | Creation of an independent regulator in 1995, White Paper on Energy Policy published in 1998, announcement of no unbundling of the incumbent in 2004, White Paper on renewable energy published in 2003. | Overall reluctance to reform, post 1990 performance saw some improvements in quality and security of supply, rapid progress in extending electricity access, prices still low by international standards and below cost-recovery levels. | Urgent need for capacity expansion as capacity is tight, pricing principles of efficiency and cost-reflectivity necessary, transparency in subsidy programme needed. |
| Thailand | Supply shortages, government's massive debt, and Asian financial crisis. | 1992 Electricity Law, IPP Law 1996, approval of independent regulator establishment in 1999, abandonment of price based pool in 2003, privatisation postponement in 2004, and establishment of energy regulatory board in 2008. | Electricity market reforms remain inactive, uneconomic tariff structure which is disadvantageous to consumers, regulation and incentive schemes do not promote efficiency but favour the state enterprises. | Political turmoil affecting reform implementation, regulatory institutions remain weak and not independent, state enterprises are favoured, promoting market competition difficult. |

The single-buyer model dominates most of the electricity sectors in Asia, Africa and some transition countries as observed in Table 3. The single buyer model is perceived to be a reasonable second-best solution in countries where the competitive model would not work (Arizu et al., 2006). In contrast, some countries in Latin America have competitive wholesale arrangements and considerable reforms have been carried out with adherence to the standard reform model. The generation segment has undergone privatization in many developing countries while the networks remain publicly owned. The privatisation of the ESI has been largely pursued in Latin America while IPPs now occupy a large market in Asia, particularly in China, Indonesia, the Philippines, India, Pakistan, Malaysia and Thailand under a single-buyer model. Overall, many developing countries are still some distance away from the full adoption of the liberalized standard model and are by and large still in transition from state control to markets.

Table 3: Power Sector Reform Matrix

| Market structure | | Private ownership and involvement | | Regulation | |
|-----------------------------------------------------------------------------------------------------------------------|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
| China, Thailand, Vietnam, Nepal, Sri Lanka, Burkina Faso, Nigeria, Côte d'Ivoire, Zimbabwe, Senegal, Morocco, Tunisia | Monolithic single buyer | China, Malaysia, Philippines, Thailand, Vietnam, Nepal, Lithuania, Turkey, Russia, Nicaragua, Colombia, Bolivia, Argentina, Brazil, Peru, Chile, Tunisia, Morocco, Kenya, Zimbabwe, Côte d'Ivoire, Uganda, Nigeria, Ghana, Cameroon, Bangladesh, Sri Lanka, India, Pakistan | Generation | Malaysia, Philippines, Thailand, Pakistan, Bangladesh, Nepal Cameroon, Nigeria, Uganda, Côte d'Ivoire, Senegal, Kenya, Argentina, Bolivia, Chile, Peru, Brazil, Nicaragua, Colombia, Russia, Turkey, Azerbaijan, Kyrgyzstan | Independent regulators exists |
| Malaysia, Philippines, Pakistan, Bangladesh, Ghana, Uganda, Kenya, Turkey, Lithuania | Unbundled single buyer | Cameroon, Côte d'Ivoire, Argentina, Bolivia, Brazil, Chile, Peru, Nicaragua, Colombia, Russia, Lithuania | Transmission | | |
| Korea Rep., Cameroon, Uzbekistan, Turkmenistan, Tajikistan, Azerbaijan, Kyrgyzstan | Monopoly | Philippines, Pakistan, Cameroon, Uganda, Côte d'Ivoire, Morocco, Chile, Brazil, Peru, Argentina, Bolivia, Nicaragua, Colombia, Russia, Lithuania, Turkey, Azerbaijan | Distribution | | |
| Argentina, Bolivia, Brazil, Chile, Colombia, Peru, Nicaragua, Russia | Wholesale competition | | | | |

Source: Ljung (2007) and authors' compilation

3. ASSESSING THE IMPACTS OF REFORMS

Several approaches have been used in the literature to assess the impacts of energy sector reforms, particularly in the electricity sector. These include social cost-benefit analysis, econometric analysis, efficiency and productivity analysis, macroeconomic analysis and specific case studies (Joskow, 2006; Pollitt, 2012). A social cost-benefit analysis (SCBA), in principle, considers the reforms as an investment and compares the costs and benefits in terms of the changes in actual and projected performance relative to a counterfactual of what would have happened in the absence of reforms (Jones et al., 1990). A SCBA can assess the overall welfare impact of reforms and the distribution of welfare. However, governments do not necessarily perform a SCBA and instead tend to rely on less formal assessments (Jamashb et al., 2005). Moreover, electricity reforms are multi-dimensional activities with many interacting factors, which cannot be captured by a SCBA but influence the social worth of a policy. The assumption that aggregate social welfare can be expressed, as an aggregation of individual social welfare is also problematic coupled with the empirical problems in quantifying the costs and benefits of a policy.

Econometric analysis is applied to test hypotheses through statistical analysis on the determinants and performance of reforms and thereby quantifying the effect of reforms on performance indicators. Performance metric regressions based on cross-section, panel data econometrics and time-series econometrics can serve this purpose. Statistical tests to assess the significant differences in the performance metrics before and after reforms are often carried out using a t-test on time-series data. However, a t-test cannot control for the effects of other variables as in a multivariable regression analysis. Cross-country econometric analysis is also complicated by model specification challenges due to the multi-faceted nature of the reforms and the diverse characteristics of the electricity sectors across countries. The absence of adequate data and the associated measurement problems pose a problem for assessment of reform impacts.

Efficiency and productivity analyses are desirable for assessing the effectiveness to transform inputs into outputs, relative to best practice. Parametric and non-parametric methods are both used in measuring productivity and efficiency. Parametric methods such as stochastic frontier analysis (SFA) use productions or cost functions and in econometric techniques. In contrary, non-parametric methods use mathematical programming techniques and do not require

specification of functional forms. Data Envelopment Analysis (DEA) is a commonly used non-parametric method that evaluates the performance of an agent relative to the frontier (Coelli et al. 2005). Frontier methodologies measure efficiency as the distance to the frontier by constructing a cost or production function such that each individual agent is benchmarked against the best practice, also known as benchmarking. Efficiency and productivity analysis can reduce the need for large datasets and especially when the data is difficult to collect. However, a shortcoming of the SFA is that it cannot adequately handle multiple outputs while multiple-output distance functions can suffer from input-output separability. On the other hand, DEA may systematically underestimate the inefficiency in small samples if the general assumptions on production and distribution are too weak.

Macroeconomic analysis use models, such as computable general equilibrium (CGE) to quantify the impact of reforms on the economy. The CGE models use actual economic data to estimate how the economy might respond to changes in policy, technology or other external factors pertaining to energy reforms. The advantage of the CGE modelling is that they attempt to model the interaction effects of sector reform with non-reforming sectors and calculate the aggregate welfare effect directly. However, they can be too aggregate with the results, failing to shed light on the relevant sectors or issues. They also imply data requirements, which are hard for many developing countries to meet. The results from the CGE analysis can be debatable given their reliance on stronger assumptions than empirical economists tend to view as being consistent with data; for example, nested constant elasticity of substitution (CES) functional forms for production functions.⁶

Single or multi-country *case studies* are desirable when in-depth investigation or qualitative analysis is needed. These studies are useful when qualitative aspects of reforms such as regulation and conflict resolution and reform dynamics such as the implementation process are crucial in assessing the efficacy of the reforms (Jamasp et al., 2005). This is because these factors are inherently difficult to capture through statistical methods. Case studies can examine issues that do not easily lend themselves to rigorous quantitative analysis or could not be analysed due to a lack of data. Hence, case studies can overcome the issues associated with model specification and accuracy of variables in representing the relevant aspect of reform. Case studies involving single or multiple countries are popular for studying the process and outcomes of electricity reforms in developing countries where institutions differ across countries.

⁶ We thank a referee for providing this information.

The above approaches provide useful insights into the effects of reforms on performance indicators (Joskow, 2006). However, it is important to adopt a comparative governance approach (Williamson, 1985) to the evaluation of the performance of alternative institutional arrangements. The comparative governance approach involves comparing the observed performance with performance under a defined set of institutional arrangements considering that ‘ideal’ textbook performance based on the virtues of perfectly competitive markets cannot be achieved in reality. Hence, one of the challenges of the ‘before and after’ assessment of reform performance is the need for developing a suitable counterfactual benchmark for comparison purposes which is difficult to establish.

3.1. Microeconomic Impacts of Reforms

This section reviews the relevant literature analyzing the impacts of reforms on several dimensions pertaining to the microeconomics of the electricity sector including pricing, economic efficiency and service quality (e.g., reliability). As market-driven reforms rely on competition and price signals, reforms are expected to lower electricity costs and retail prices and prevent the exercise and abuse of market power while improving the overall efficiency of the sector (Joskow, 1998).⁷ However, “*the cure for market power can be worse than the disease itself*” as, noted in Joskow (2006). Mitigating the exercise of market power ex-post has been a major challenge faced by many sector regulators (Newbery, 1997).

It is noteworthy that, prior to the reforms, in developing countries under-pricing of electricity was common and a driving factor for the deterioration of the performance of the sector due to underinvestment. Another notable characteristic was that electricity prices often represented cross-subsidization from industrial customers to households. The rationale for these pricing policies is that they fostered desirable social goals such as helping poorer customers who would otherwise be disadvantaged although the richer groups of the society tend to benefit more from these subsidies (Kessides, 2012). Hence, market based pricing and removal of subsidies, a source of inefficiency, is expected to result in increased prices to cost-reflective levels. On the other hand, in the event of market power, prices are expected to fall to cost-reflective levels due to the virtues of competitive forces.

⁷Market power in electricity generation is understood as the ability of a generator to deviate the price from the competitive levels in ‘a profitable way’ for a continued period of time. Vertical market power may occur when a single generator controls more than one aspect of electricity production while horizontal market power results due to the concentration of ownership.

3.1.1. Impacts of reforms on electricity pricing

Cost-reflective electricity prices imply that prices are set at an efficient level. It is expected to incentivize necessary investments through private sector and foreign investments. It provides incentive to reduce costs, increase efficiency and induces innovation to increase profits (Newbery, 1995). Market driven reforms are expected to establish cost-reflective pricing by harnessing competition and leading to improved efficiency and lower prices. Reforms would encourage entry of new actors by providing better incentives so that new and efficient entrants and technologies would create downward pressure on prices (Fan, 2007). Hence, reforms are expected to lead to lower price-cost margins and cost-reflective pricing where prices move towards their long-run marginal costs (LRMC). However, in many developing countries, regulated prices were inefficiently low and liberalization would mean raising the prices towards cost-reflective levels and provide better investment incentives.

However, there is no consensus regarding the price impact of reforms. Evidence suggests that privatisation did not lower the costs in the short run as government interference with investment decisions led to increased costs (Pollitt, 1995). Moreover, the evidence of pricing impacts of reforms varies across jurisdictions which undertook the reforms. Three studies by Nagayama (2007; 2009) and Erdogdu (2011) are of notable for assessing the worldwide effect of reforms on prices. Nagayama (2007) shows that the introduction of foreign IPPs, privatization and introducing retail competition lowered prices in some jurisdictions though not across all jurisdictions undertook reforms. Regulatory institutions in developing countries are often not sufficiently independent implying that political interference can prevent prices from being cost-reflective. Country level corruption on contracts granted to the IPPs also prevented the reforms from producing their intended effects in developing countries such as in Southeast Asia (Henisz and Zelner, 2002). On the other hand, ESMAP (2011) shows that vertical unbundling in developing countries decreased electricity tariffs by 10% indicating a higher degree of competitiveness.

Nagayama (2009) shows that progress in liberalization led to declining cross-subsidies across the electricity sectors in Asian developing countries. Electricity prices rose in these countries in the aftermath of reforms. In Latin America, the impact of liberalization on prices is mixed. The wholesale and retail prices have often risen due to unbundling and privatization in order to assure return in investment expected by private investors.

The effects of reforms on the price cost-margin (i.e. the difference between electricity price and cost) and cross subsidies can be different between industrial and residential consumers although there are limited studies of these. Erdogdu (2011) showed that participation of IPPs in the generation market and the existence of wholesale markets seem to decrease the industrial price-cost margin in Latin American countries. The study found that the establishment of wholesale electricity markets and regulators had a downward effect on the residential price-cost margins in developing countries while unbundling, with privatization, also had a decreasing effect on residential price-cost margins in Latin America. Hence, the overall impacts of reforms on electricity prices seem to also depend on the level of industry restructuring.

The impact of reforms on electricity prices has been less frequently studied on a regional basis and the focus of most research has been at the utility level. India provides an interesting case to assess the differences in regional outcomes of reforms considering that its different states share a common economic and political system. Sen and Jamasb (2012) analyze the impacts of individual reform measures on key economic and sector variables for different Indian states and showed that average prices were unaffected by reforms. Meanwhile passing of tariff order in different states as a mechanism to correct price distortions significantly lowered the industrial prices. Tariff order also rationalized electricity pricing by lowering the cross-subsidies between industrial and residential customers, while unbundling lowered the cross-subsidies between the industrial and agricultural customers. In Orissa, average electricity tariffs increased from 1991 to 2001 (Kundu and Mishra, 2011). The price of electricity increased sharply particularly for agricultural customers after the reforms due to the abolishment of government subsidies.

In Latin America, the change in the regulatory regime from cost-based to price-caps did not produce a clear pattern of price development although the changes in ownership and regulatory regime in the distribution segment led to a decline in retail prices in general (Estache and Rossi, 2005). The price fall, however, did not match the productivity gains. However, Balza et al. (2013) estimated that an increase in cumulative private investment by 1% led to a 0.015% reduction in electricity prices across some countries Latin America. The quality of regulation in reforming countries is sensitive to pricing impacts of sector reforms. In Peru, for example, the restructuring and privatization of the distribution utilities led to price increases (Anaya, 2010). In Argentina, wholesale electricity prices as well as the real average tariffs fell from the 1992 levels as a result of increased competition due to industry

restructuring and privatization even though the prices froze in the wake of an economic crisis in 2002 due to the devaluation of the national currency (Haselip and Potter, 2010). Average node prices for electricity declined in Chile from the 1982 levels with the implementation of reforms while prices decline by 30% in Argentina (Pollitt, 2004). In Colombia, prices fell by 20% (Ayala and Millan, 2003). Nonetheless, assessing the causal effect of the price fall for low-income groups is complicated in Chile as targeted subsidies and electrification policies can also produce the effect rather than strictly privatization (Paredes, 2001).

In other developing countries, the impact of reforms on electricity prices are opposite of that in Latin America. For example, in Turkey privatization of the distribution utilities did not yield the expected retail price declines in the initial years although wholesale tariffs exhibited a reduction (retail price increased by 6% while wholesale price decreased by 10% (Karahan and Toptas, 2013). In Sub-Saharan Africa, prices have been generally high as compared to the rest of the world irrespective of electricity reforms.⁸ Reforms also had no impact on prices in South Asian countries such as Bangladesh and Pakistan where prices were not cost-reflective and politically determined (Bhattacharya, 2007).

Electricity prices continue to be below the cost recovery levels giving rise to high commercial losses among the transition countries such as Georgia, Moldova, Ukraine and the Commonwealth of Independent States (CIS) since reforms started in the early 1990s (Nepal and Jamasb, 2012a). The difficulty of the vulnerable consumers to absorb further price increases has been a concern and often prevented pursuing tariff reforms in many transition countries (Fankhauser and Tepic, 2007). In Turkey, for example, the introduction of a tariff system reflecting the costs affected the production and consumer prices of electricity differently. The effect on consumer prices was slightly lesser than for producer prices (Akkemik, 2011).

⁸ In most Sub-Saharan African countries, the average electricity tariff remained almost twice as high as in other parts of the world regardless of whether this was prior to or after the reforms. The prevailing high electricity tariffs in these countries do not cover the full costs of electricity supply. Countries such as Angola, Malawi, South Africa, Zambia and Zimbabwe have maintained highly subsidized prices below the cost levels (Eberhard et al., 2011).

Table 4: Reforms and Electricity Prices

| Study | Approach | Region | Data | Method | Policy impacts and relevance |
|-----------------------------------|-----------------------|----------------------|--------------------------------------------------------------------|------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Akkemik (2011) | Case study | Turkey | Macro and micro variables with focus on energy producing sectors | Single country; social accounting matrix | Cost reflective electricity tariff affect consumers prices slightly less than producer prices |
| Anaya (2010) | Cost-benefit analysis | Peru | Electricity distribution companies (privatised and non-privatised) | Single country | Privatisation contributed to price increase |
| Balza, Jimenez and Mercado (2013) | Econometric | Latin America | Panel data: 18 countries, 1971-2010 | Generalised least squares | No robust results in terms of privatisation and end-user-prices; strong and robust association between regulatory quality and electricity prices |
| Bhattacharya (2007) | Case study | South Asia | Power sector indicators | Multi-country | Reform undertaken produced no significant results, electricity prices still highly subsidised |
| Eberhard et al. (2011) | Case study | Africa | Power sector indicators | Multi-country | Eliminating pricing inefficiencies can close the funding gap in the power sector |
| Erdogdu (2011) | Econometric | Global | Panel data: 63 developed and developing countries, 1982-2009 | Fixed effects, random effects | No uniform pattern for the impact of reforms process as a whole on price-cost margins and cross-subsidy levels; different impact of different reform steps |
| ESMAP (2011) | Econometric | Global | Panel data; 20 countries with different system sizes | Fixed effects, random effects | Vertical unbundling reduced electricity tariffs by 10% |
| Estache and Rossi (2004) | Econometric | Latin America | Distribution companies of 14 countries | Correlation | Fall in prices in general did not match the productivity gains |
| Fankhauser and Tepic (2007) | Case study | Transition economies | Affordability indicators for utilities | Multi country | Level of tariffs needed for cost recovery bear important affordability |

| | | | | | |
|---------------------------|-------------|------------------------|-----------------------------------------------------------------------|-------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | | | | | consequences |
| Haselip and Potter (2010) | Case study | Argentina | Power sector indicators | Single country | Reforms led to price decline until macroeconomic crisis |
| He et al. (2011) | Macro study | China | Coal and electricity prices | CGE modelling | Coal price increase caused a rise in the costs of electric power industry while the influence gradually descended with increases in coal price |
| Karahan and Toptas (2013) | Case study | Turkey | Power sector indicators | Single country | No reduction in retail electricity prices after reforms |
| Kennedy (2003) | Case study | Transition economies | Power sector indicators | Multi-country | Implementation of reform should be enhanced to improve reform performance |
| Kundu and Mishra (2011) | Econometric | Indian state of Orissa | Survey based approach | Partial least squares | Some consumers group benefited (e.g. industrial) while some lost (e.g. agricultural) |
| Nagayama (2007) | Econometric | Global | Panel data: 83 countries (26 developed); 1985-2002 | Ordinary least squares, fixed effects, random effects | Neither unbundling nor introduction of wholesale market on their own necessarily reduce prices; unbundling may reduce prices when coexisting with independent regulator |
| Nagayama (2009) | Econometric | Global | Panel data: 78 developing, developed, transition countries; 1985-2003 | Ordered response, fixed effects, random effects | Higher electricity prices drive liberalisation; liberalisation models does not necessarily reduce electricity price |
| Pollitt (2004) | Case study | Chile | Power sector indicators | Single country | Average node prices declined after reforms |
| Sen and Jamasb (2012) | Econometric | India | Panel data: 19 Indian states, 1991-2007 | Bias corrected fixed effects | Political economy factors led to adverse outcomes in the initial stages of reforms |

3.1.2. Impacts of reforms on quality of service and access

One of the principal aims of reforms in most reforming countries has been to enhance the quality of energy supply (Joskow, 1998; Briceno-Garmendia et al., 2004). Reforms were expected to enhance energy production, lead to efficient utilisation of existing capacities and add new capacities by attracting investments and reduce energy losses. Studies by Cubbin and Stern (2004, 2006), Erdogdu (2014) and Zhang et al. (2008), find that market competition and regulatory governance as result of reforms have brought enhanced service penetration, generation capacity expansion, capacity utilization and reserve margins in some developing countries.

The effects of reforms on quality of service and access have differed across the regions as showed by Nagayama (2010) using econometric and panel data analysis. The introduction of foreign IPPs when coexistent with independent regulators and unbundling on its own increased the per capita generation capacity in Asian developing countries while the establishment of independent regulator had the opposite effect. The per capita generation capacity also increased among the LACs with the introduction of wholesale market and power exchange but reforms triggered different impacts on transmission and distribution (T&D) losses (Nagayama, 2010). The same study found that the introduction of foreign IPPs reduced T&D losses in Asian developing countries.

On the other hand, private sector investments in the transmission and distribution networks contributed to a decline in electricity losses in Latin America (Balza et al., 2013). Technical and non-technical losses fell sharply from above 20% in 1992 to just above 10% in 2007 in Argentina (Pollitt, 2008). The number of minutes of supply interruption per year fell to 2.1 in 2003 from 9.6 in 1997 in Chile while distribution losses fell from 19.8% in 1987 to 5.6% in 2003 (Pollitt, 2004). Also, generation capacity increased in many LACs except in Brazil post reforms (Millan, 2005).

Reforms triggered different impacts on the plant load factor, T&D losses and gross electricity generation among the Indian states (Sen and Jamasb, 2012). Unbundling and tariff orders had a positive and significant effect on plant load factors. Gross electricity generation in India increased with the introduction of the IPPs while privatisation of the distribution segment led to lower energy losses. The average level of T&D losses in Sub-Saharan Africa was around 27.5% in 2009 although the system losses substantially range from 14.5% in Angola to 68% in Swaziland (ESMAP, 2009). Reforms have also been unable to reduce electricity theft in

most regions of the developing world considering that the quality of governance such as effective accountability, political stability, and government effectiveness and corruption control can reduce energy theft in developing countries (Smith, 2004).

The international experience with restructuring, privatisation and liberalisation has exposed the vulnerabilities in electricity supply in various countries (Hall, 1999). For example, the end of 1997 saw repeated power cuts in Rio de Janeiro, Brazil followed by Buenos Aires, Argentina where a 10-day blackout occurred in 1999. These supply vulnerabilities coincide with the less than anticipated increase in private investments in the transmission and distribution networks in the reforming countries. In addition, the progress toward reforms has coincided with limited government support for research and development (R&D) something that threatens the sustainability of efficiency improvements in the electricity industries of developing countries (Erdogdu, 2013).

Electricity reforms in developing countries were often mooted with a view to increase access across all segments of the population (Sinha, 2003). This is because the participation of the private sector in energy production provides more investment to expand the electricity supply capacity and thus would also enhance the access to electricity. However, the evidence on electrification is mixed. In South Asia, reforms did not necessarily accelerate access to energy, whereas in Latin America, it reached many new consumers. Sihag et al. (2007) finds that the reform in the Indian State of Orissa, did not help enhance the electrification rate. Based on the South Asian experience, Bhattacharyya (2006) concludes that initiatives aimed at intensifying rural electrification have had limited impact in improving the energy access for the poor in the region.

On the other hand, other studies, such as, Balza et al. (2013) and Kozulj and Di Sbroiavacca (2004) show that electricity sector reforms had increased electricity coverage in parts of South America. For example, the post-reform electrification rates in Argentina, Peru and El Salvador respectively increased to 95, 72 and 76% from the respective pre-reform rates of 91, 38 and 62%. In Chile, the number of households without electricity decreased to 14% in 2002 from 62% in 1982 after reforms (Pollitt, 2004).

Table 5: Reforms and Electricity Quality and Access

| Study | Approach | Region | Data | Method | Policy impacts and relevance |
|-------------------------------|--------------|--------------------|--------------------------------------------------------------|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| Cubbin and Stern (2004) | Econometrics | Global | Panel data: 28 developing countries; 1980-2001 | OLS, fixed effects | Regulatory law and governance positively related to higher per capita electricity generation and capacity |
| Cubbin and Stern (2006) | Econometrics | Global | Panel data: 28 developing countries; 1980-2001 | Fixed effects, error correction models | Regulatory law and governance positively related to higher per capita electricity capacity controlling for privatization and competition |
| Erdogdu (2013) | Econometrics | Global | Panel data: 27 countries, 1974-2008 | Fixed effects; random effects | Reform progress led to decline in R&D investments |
| Erdogdu (2014) | Econometrics | Global | Panel data: 55 developed and developing countries, 1975-2010 | Fixed effects, random effects | Reform progress led to higher levels of electricity supply self-sufficiency |
| ESMAP (2009) | Case study | Sub-Saharan Africa | Power sector indicators | Multi country | High number of outages per year and long delays with electrical connections |
| ESMAP (2011) | Econometrics | Global | Panel data; 20 countries with different system sizes | Fixed effects; random effects | Introduction of independent regulation escalated access by 50% |
| Hall (1999) | Case study | Global | Power sector indicators | Multi-country | reforms have coincided with rising power cuts and blackouts |
| Kozulj and Sbroiavacca (2004) | Case study | Latin America | Power sector indicators | Multi-country | electrification levels increased after reforms |
| Millan (2005) | Case study | Latin America | Power sector indicators | Multi country | generation capacity expanded vigorously except in Brazil after reforms |
| Nagayama (2010) | Econometrics | Global | Panel data: 86 developed and developing countries, 1985-2006 | Fixed effects | IPPs, unbundling, regulatory agency and creating wholesale markets reduced transmission and |

| | | | | | |
|--------------------------|-----------------------------|----------------------|----------------------------------------------------------------------------|-------------------------------|----------------------------------------------------------------------------------------------------------------------|
| | | | | | distribution losses |
| Nepal and Jamasb (2012a) | Econometrics | Transition economies | Panel data: 27 countries, 1990-2010 | Bias corrected fixed effects | Power sector reform on its own did not produce any significant impacts on T&D losses |
| Nepal and Jamasb (2012b) | Case study | Nepal | Power sector indicators | Single country | Electricity losses in South-Asia including Nepal still remain high, capacity and power shortages prevail |
| Pollitt (2008) | Case study | Argentina | Power sector indicators | Single country | Reforms successful in improving quality prior to the collapse of Argentine peso |
| Prasad (2008) | Case study | Africa | Energy sector indicators | Multi-country | Energy reforms only impacts access when adjusted to local conditions of the poor |
| Smith (2004) | Case study/ econometrics | Global | 102 countries: electricity losses, governance indicators for 1980 and 2000 | Correlation/ multi country | Losses have increased in many developing countries after reforms |
| Zhang et al. (2005) | Econometrics | Global | Panel data: 25 developing countries, 1985-2001 | Fixed effects | Independent regulation and competition before privatisation important for higher electricity generation and capacity |
| Zhang et al. (2008) | Econometric | Global | Panel data: 51 developing countries, 1985-2000 | Fixed effects | On their own privatisation and regulation do not lead to obvious gains in economic performance |

*3.1.3. Impacts of reforms on productivity and economic efficiency*⁹

The changes in market structure, the role of the state and the regulation of the sector were all aimed at improving utility efficiency and productivity levels through the introduction of market competition (Wolfram, 1999). The evidence of reforms in improving efficiency and productivity in the electricity sector is positive especially in Latin America, which is also the most studied region. However, the efficiency and productivity impacts of these reforms remain least studied in South Asia and Africa. There are only few international studies of utility efficiency and reforms.

An earlier study by Yunos and Hawdon (1997) found that changes in the ownership did not automatically resolve the efficiency problems in the absence of competition among the least developed countries and significant efficiency gaps persisted between small scale and large electricity providers. Rodriguez-Pardina and Rossi (2000) finds some evidence that suggest that reforming countries had a better performance than those which did not. Although technical efficiency among the major distribution companies in South America marginally improved between 1994 and 2001, the results suggested considerable scope for improvement among the firms (Estache et al., 2004). The increments in productivity seem to be in line with the degree of incentives built in regulation while private companies operating under rate of return regulation exhibited similar labor productivity levels as public firms (Estache and Rossi, 2005).

The labor productivity in the electricity distribution experienced an increase after reforms in Argentina (Pollitt, 2008) and in Chile since the privatisation of leading companies (Fischer et al., 2003). The incorporation of distribution value added (VAD) in the tariff setting processes and regulation of distribution utilities contributed to efficiency of distribution in Chile (Sanhueza et al., 2004). In Brazil, where privatisation took place before the establishment of the sector regulator, it showed no statistically significant impact on operating cost efficiency of distribution but technical efficiency declined when considering the total expenditures (Motta, 2004). Overall, the reform in Brazil does not seem to have improved the efficiency of the distribution networks between 1998 and 2005 (Ramos-Real et al., 2009).

⁹ Economic efficiency is a combination of technical and allocative efficiency (Coelli et al., 2005). Firms operating on the production frontier are said to be technically efficient while allocative efficiency in input selection imply selecting that mix of inputs (such as labor and capital) that produces a given quantity of output at minimum cost (given the input prices which prevail). Productivity of a firm is the ratio of the output(s) that it produces to the input(s) that it uses.

In Peru, earlier studies by Bonifaz and Rodguez (2001) and Bonifaz and Santin (2000) using 3 years of data (1995-1998) found little evidence of technical improvement in electricity distribution while privatised distribution firms did not outperform the state owned utilities. However, later studies such as by Perez-Reyes and Tovar (2009; 2010) using a decade long data (1996-2006) showed improvements in efficiency and productivity of electricity distribution in Peru occurred with the adoption of regulatory reform although privatisation proved to be advantageous only in the initial years after the reform. There seems to exist a positive relationship between the restructuring and reform of electricity distribution and productivity improvement in Peru. Management practices seem to be important in the Peruvian electricity distribution due to which private utilities are less inefficient than public utilities (Bonifaz and Jaramillo, 2010).

In Colombia, the reforms of the 1990s improved the average efficiency levels of electricity distribution with regulatory policy engendering a positive effect while ownership produced no conclusive effect (Pombo and Ramirez, 2002a). Technological improvements and regulatory policy have had a positive effect on average efficiency but the divide between good performers and bad performers widened after the reforms (Pombo and Ramirez, 2002b). Mello and Espinoza (2004) found no significant productivity change among the 20 distribution companies between 1993 and 2003, although contextual factors mattered significantly. In contrast, Pombo and Taborda (2006) showed that plant efficiency and productivity increased after the regulatory reform of 1994 although the efficiency of distribution companies did not improve. Nonetheless, the Colombian distribution network exhibits high and persistent inefficiency among firms (Galan and Pollitt, 2014). Rural companies and firms with small customers seem to have experienced the largest efficiency gains over the 15 years after the reforms.

Estache et al. (2008) attempted at documenting efficiency levels in Africa's electricity firms based on a sample of 12 operators providing services in the 12 countries of the Southern Africa Power Pool. The study relied on the DEA decomposition technique to estimate the changes in total factor productivity (TFP). The results showed comparable levels of efficiency and performance levels in the region but found no clear correlation between the efficiency improvements with the adoption of reforms. In Sub-Saharan Africa, an early efficiency analysis of the Côte d'Ivoire electricity companies did not find significant performance improvement in post-privatization period and the technical efficiency measures behaved irregularly since privatization (Plane, 1999).

Some studies have examined efficiency and productivity effects of reforms in the transition economies of Eastern Europe. In Poland, technical efficiency of the distribution companies increased during the transition process while allocative efficiency deteriorated (Cullman and von Hirschhausen, 2008a). The cross-country analysis suggested that the Polish distribution companies were marginally inefficient while the Czech Republic featured the highest efficiency while Slovakia and Hungary occupied the middle range (Cullman and von Hirschhausen, 2008b). The efficiency analysis of the Ukrainian privately and publicly-owned distribution firms after a new regulatory authority and distribution privatisations suggested that private firms reduced commercial and non-commercial network losses more than the publicly owned firms (Berg et al., 2005). This implies that privatization had a positive effect on technical efficiency in all four countries. Also, the average efficiency of thermal generation plants grew in China and autonomy from the central government was one of the important determinants (Lam and Shiu, 2004). In Turkey, private distributors showed better technical scale efficiency on average during the early years of reforms (Bagdadioglu et al., 1996; Celen, 2013).

A limited number of studies have assessed the efficiency and productivity of the reforms in developing Asian countries. The performance and efficiency analysis of the Indian generation companies supported the policy of unbundling the sector while state owned companies appeared inefficient (Jain et al., 2010). However, privatisation brought about different impacts on employee productivity in the state of Orissa as some employees benefitted while others did not (Kundu and Mishra, 2012). In contrast, technical performance in the Thai electricity industry was mainly driven by technological and productivity improvements (Wattana and Sharma, 2011). In the Philippines, productivity did not improve significantly despite the reforms being instituted in 2001 (Bautista et al., 2011).

In China, unbundling of the integrated electricity utility - the State Power Corporation (SPC) improved productivity and operational efficiency among the large coal-fired power plants controlling for substantial heterogeneity in the technical profile of the plants (Zhao and Ma, 2013). Finally, empirical analysis by Nakano and Managi (2008) and Goto and Sueyoshi (2009) showed that deregulation and regulatory reforms contributed to productivity growth in steam power-generation sector in Japan for the period 1978-2003.

Table 6: Reforms and Efficiency and Productivity

| Study | Approach | Region | Data | Method | Policy impacts and relevance |
|--------------------------------------|---------------------------|-------------------------------------------|----------------------------------------------------------------------|-------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| Bagdadioglo, et al. (1996) | Non-parametric | Turkey | Cross section of 70 distribution operators in 1991 | DEA | Private operators are more efficient than public operators |
| Bautista et al. (2011) | Non-parametric | Philippines | 120 electric cooperatives, 2001 to 2006 | DEA | Reforms did not drive productivity in the sector |
| Berg et al. (2005) | Parametric/non-parametric | Ukraine | 24 distribution companies, 1998-2002 | Stochastic production frontier/DEA | Private operators responded well to incentives than public operators, perverse regulation worsens incentives |
| Bonifaz and Santin (2000) | Non-parametric | Peru | Panel of 19 distribution operators 1995-1998 | DEA with 2 nd stage regressions | Privatisation did not lead to an improvement in terms of efficiency |
| Bonifaz and Jaramillo (2010) | Parametric | Peru | Panel of 19 distribution companies for the period 2000-2008 | Stochastic cost frontier | Private utilities are less inefficient than public utilities due to better management practices |
| Celen (2013) | Non-parametric | Turkey | 21 companies for the period 2002-2009 | DEA with Tobit 2 nd stage regression | Private ownership positively affect efficiencies |
| Cullman and von Hirschhausen (2008a) | Parametric/non-parametric | Poland | 32 distribution companies between 1997 to 2002 | DEA/SFA | Technical efficiency improved with reforms but allocative efficiency deteriorated |
| Cullman and von Hirschhausen (2008b) | Non-parametric | Poland, Czech Republic, Slovakia, Hungary | 47 Eastern European regional companies, 37 German companies | DEA/Free Disposal Hall | Czech Republic and Slovakia feature the highest efficiency, privatisation had a positive effect in all countries |
| ESMAP (2011) | Parametric | Global | Distribution companies from 20 countries with different system sizes | Fixed effects; random effects | Introduction of independent regulator increased labor productivity by twice as high as systems that have introduced regulation |
| Estache et al. (2004) | Parametric/non-parametric | Latin America | 84 electricity distribution companies 1994- | Stochastic cost function, | Technical efficiency marginally improved but scope for |

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|-----------------------------------|----------------------------|----------------------------|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| | | | 2001 | DEA, labor requirement function | improvement remains |
| Estache and Rossi (2005) | Parametric | Latin America | 127 distribution companies 1994-2001 | Stochastic production function/lab or requirement function | Incentives in embedded in regulation crucial for productivity increases |
| Estache et al. (2008) | Non-parametric | Southern African countries | 12 operators of 12 different countries, 1998-2005 | DEA | No clear correlation between adoption of reforms and improvements in efficiency |
| Galan and Pollitt (2014) | Parametric | Colombia | Panel of 21 electricity distribution firms for the period 1998-2012 | Dynamic SFA model | Increases in efficiency among rural firms only manifested during the last five years driven by improvements in service quality and energy losses occurred |
| Goto and Sueyoshi (2009) | Parametric | Japan | Annual observations in 9 companies from 1983-2003 | Multi-product translog cost function, random effects maximum likelihood estimator | Improvements in productivity growth after deregulation |
| Jain, Thakur and Shandilya (2010) | Parametric/n on-parametric | India | 30 state –owned utilities for the year 2007-2008 | DEA/SFA | Unbundling drives efficiency in electricity generation |
| Lam and Shiu (2004) | Non-parametric | China | Panel of 30 municipal autonomous regions and provincial thermal plants 1995-1996 | DEA with 2 nd stage regressions | Average efficiency increased at 2% |
| Malik et al. (2015) | Parametric | India | Unbalanced panel of 385 electricity generating units for the years 1998-2009 | Panel data econometric based in fixed effects | States unbundling before the Electricity Act of 2003 experienced improvements in operational efficiency especially 3-5 years after unbundling |
| Mello and Espinoza | Parametric | Colombia | Panel of 20 distribution | Free Disposal | Environmental variables mattered significantly |

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|------------------------------|-------------------------------|---------------|--------------------------------------------------------------------------|---------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| (2004) | | | companies 1999-2003 | Hull (FDH) | |
| Motta (2004) | Parametric/ non-parametric | Brazil | Distribution companies 1994 and 2000 | DEA/ Stochastic production frontier | Privatisation has no effect on operating cost efficiency, makes case for including capital costs in benchmarking |
| Nakano and Managi (2008) | Parametric/ non-parametric | Japan | 10 companies, 1965-2003 | DEA/ generalised method of moments | Regulatory reforms have contributed to productivity growth in the steam power-generation |
| Perez-Reyes and Tovar (2009) | Non-parametric | Peru | 14 distribution companies for the period 1996-2006 | DEA | Reforms led to improvements in efficiency and productivity |
| Perez-Reyes and Tovar (2010) | Parametric | Peru | 14 distribution companies between 1996 and 2006 | Distance function | Incentives lead by the reform process made firms more efficient |
| Plane (1999) | Parametric | Côte d'Ivoire | Time-series from 1959-1995 | Stochastic production function | Significant but irregular gains from the privatization of management |
| Pollitt (1995) | Non-parametric | Global | 768 thermal plants from 14 countries including South Africa and Thailand | DEA with 2 nd stage regressions /Tobit | Privatisation did not lower costs in the short run, government interference with investment increase costs |
| Pombo and Ramirez (2002a) | Non-parametric | Colombia | Panel of 33 distribution companies from 1988-2000 | DEA with 2 nd stage regression | Reforms improved average efficiency levels |
| Pombo and Ramirez (2002b) | Non-parametric | Colombia | Panel of 33 generation and 12 distribution companies 1988-2000 | DEA with 2 nd stage regression | Technology improvements and regulatory policy had positive effect on average efficiency levels |
| Pombo and Taborda (2006) | Non-parametric | Colombia | 12 electricity distribution companies from 1985-2001 | DEA | Profitability, partial input productivity, and output improved; plant efficiency and productivity increased after reform |
| Ramos-Real et | Non- | Brazil | Panel of 18 | DEA | Incentives generated in |

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|------------------------------------|----------------|---------------------------|--------------------------------------------------------------------------------------------------------|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| al. (2009) | parametric | | distribution companies from 1998-2005 | | the reforms process incapable of making firms behave in more efficient manner |
| Rodriguez-Pardina and Rossi (2000) | Parametric | South America | 30 electricity distribution companies from 10 countries 1994-1998 | stochastic production function | Partial evidence of reformers performing better than non-reformers |
| Sanhueza et al. (2004) | Non-parametric | Chile | 35 distribution companies for the year 2000 | DEA | Incorporating distribution VAD improved efficiency |
| Wattana and Sharma (2011) | Non-parametric | Thailand | Thai electric industry, time series data from 1980-2006 | DEA | Industry reforms not significant in driving efficiency |
| Yunos and Hawdon (1997) | Non-parametric | Least developed countries | Cross-section generation data, 27 countries, panel of utilities of Malaysia, Thailand and UK 1975-1990 | DEA | Ownership change does not resolve efficiency problems in the absence of competition, efficiency gaps between small scale and large providers |
| Zhao and Ma (2013) | Non-parametric | China | Balanced panel: 34 large power plants for 1997-2010 | DEA | Operation efficiency improved on average, unbundling boosted productivity |

3.2. Macroeconomic Impacts of Reforms

This section reviews the literature analyzing the impacts of reforms on macroeconomic indicators such as economic welfare, economic growth and poverty reduction. Electricity is one of the main inputs to economic development especially in developing countries where economic growth is constrained due to lack of infrastructure and reliable supply of electricity (Stern and Kander, 2012). Therefore, any programs and policies that relax the electricity supply constraints are expected to generate positive impacts on economic welfare and growth and also reduce poverty. Below we discuss this argument based on empirical evidence.

3.2.1. Impacts of reforms on economic welfare

The economy-wide welfare impacts of reforms are examined by a few studies. Galal et al. (1994) estimated the welfare impacts of the privatisation of the Chilean distribution and

generation companies and is one of the first and most comprehensive such studies. The privatisation of the Chilean electricity companies (a distribution and a power generation utility) led to a permanent gain in social welfare equivalent to 2.1% of 1986 sales value. However, the gains were achieved at a fiscal loss¹⁰ and two-thirds of the aggregate gains accrued to foreign shareholders. In Brazil, approximately 60% of the distribution market and 20% of the generation market was privatized between 1995 and 2000. The privatization of the distribution created a one-off gain equivalent to 2.5% of the GDP in the form of the privatization proceeds although the producers captured two-thirds of the proceeds (Mota, 2003). Consumers could have benefited more from privatization had the regulatory institutions been fully established at the beginning of the privatization process. The economic welfare impacts of partial privatization and restructuring in Peru proved worthwhile and the gains amounted to 542 million \$US in 2007 prices (Anaya, 2010). The distribution of the gains suggested that government and producers benefited the most from welfare gains while consumers benefited the least.

Toba (2007) studied the welfare impacts of private sector participation in the Philippines electricity generation, through liberalization of the market for IPPs during the power crisis of 1990-1993. The introduction of IPPs presented significant gains contributing to resolving the crisis and promoting economic and social development while consumers and investors were the net gainers. However, only about one-quarter of the total private investors' gains are transferred to the domestic investors, as most investors are assumed to be foreigners. The largest share of the net benefit equivalent to a net present value of 10.4 billion \$US (in 1999 prices) was distributed to consumers. At the same time, the domestic and foreign investors also gained while the government was the loser.

In Israel, Tisher et al. (2006) undertook a cost-benefit analysis summarizing the government's reform plan using an unregulated regime as the counterfactual. The results suggested that the government's reform plan would only yield a small net benefit even when it was carried out flawlessly relative to the regulated regime. The reforms would also lead to large increases in electricity producers' profit and government tax receipts at the expense of the consumers. As such, a less-than-perfect transition to competition could easily preclude the potential gains of the government plan.

¹⁰ The fiscal loss would have some negative implications to social welfare, which was ignored by the study.

Table 7: Welfare Effects of Reforms

| Study | Approach | Country/ Region | Date | Method | Policy impacts and relevance |
|-----------------------|----------------------------|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Anaya (2010) | Single country case study | Peru | Privatisation of 2 electricity distribution companies: Electrolima and Electro Sur Medio | Social cost-benefit analysis | Privatisation was worthwhile in terms of social welfare, government and producers benefited the most while consumers benefitted the least due to price increases |
| Galal et al. (1994) | Multi-country case studies | Global | Before and after performance indicators data of public enterprises divestitures in UK, Chile, Malaysia and Mexico | Social cost-benefit analysis | Privatisation combined with regulation can enhance welfare, private ownership improves efficiency of generation, promotes profit maximisation and increases value of regulation |
| Mota (2003) | Single country case study | Brazil | Privatisation of 21 electricity distribution and supply businesses between 1995-2000 | Social cost-benefit analysis | Economic welfare (net benefits) was significant but most of it went to the producers; consumers could have benefited more from privatisation in the presence of tougher regulation |
| Tishler et al. (2006) | Single country case study | Israel | Impacts on the generation, transmission and distribution in accordance to the 2003 government announcement to undertake a functional unbundling of ESI | Cost-benefit analysis | Reform will only yield a small net benefit even when carried out flawlessly, will increase profits for producers and government tax receipts at the expense of customers, incentive regulation of the sector thereby is desirable |
| Toba (2007) | Single country case study | Philippines | disaggregated and detailed datasets covering pre and post private participation periods from 1988 to 1997 | Social cost-benefit analysis | Consumers and investors were net gainers while the government lost, reform with private participation increased economic welfare |

3.2.2. Impacts of reforms on economic growth

A few studies have provided evidence of positive impacts of reforms on economic growth. Lack of electricity infrastructure and reliable energy supplies constrain economic growth in developing countries (Bruns et al., 2014). Sen and Jamasb (2012) show that increased stock of electricity infrastructure has made a significant contribution to industrial economic output in India. Also, Easterly and Levine (2003), Rodrik et al. (2004) and Acemoglu and Robinson (2010) show a positive relationship between stock (as well as quality) of the infrastructure and per capita GDP growth.

Empirical evidence also suggests a strong and positive link between regulatory quality in all economic sectors and economic performance in developing countries (Jalilian et al., 2007). Electricity reforms can stimulate economic growth by improving access to commercial electricity (Ozturk, 2010). However, only a few studies have directly examined whether the reforms serve as determinants of economic growth by using per capita GDP and employment levels as indicators of economic growth.

Nepal and Jamasb (2012a) and Carvalho et al. (2016) examine the impact of reforms on per capita GDP in transition economies, particularly in the Former Soviet Republics (FSR). The results show significant and positive impacts of reforms on GDP. Similar results have been found for India in Sen and Jamasb (2012), which econometrically analyzed the determinants and impact of electricity sector reforms in the Indian states, giving special regard to the political economy and regional diversity factors of the country.

Chisari et al. (1999) estimated the macroeconomic effects of privatisation and regulation of utilities including energy that began in 1989 in Argentina. The privatization of generation and distribution and gas all had positive effect on GDP. The privatisation of the gas sector had the greatest effect on GDP amounting to 0.31% increase in GDP in the presence of regulation. Privatization of energy utilities did not contribute to the sharp rise in unemployment between 1993 and 1995. The fiscal consequences of privatization and regulation of infrastructure utilities including energy suggested that the country gained more in macroeconomic terms from the net present value of subsidy cuts (Benitez et al., 2001). Reallocating the resources freed up by energy subsidies removal to more productive public spending can help boost economic growth over the long run (IMF, 2013).

Table 8: Reforms and Economic Growth

| Study | Approach | Region | Data | Method | Policy impacts and relevance |
|--------------------------|-------------|---------------------------|----------------------------------------------------------------------------|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Benitez et al. (2001) | Macro study | Argentina | Privatisation, fiscal reforms and regulation data | CGE | Gains from subsidy cuts and reforms, and privatisation of energy utilities not responsible for increased unemployment |
| Chisari et al. (1999) | Macro study | Argentina | Performance data before and after privatisation of the Argentine utilities | CGE model | Privatisation resulted in different types of efficiency gains with significant macro-economic benefits, privatisation not the cause for rising unemployment |
| IMF (2013) | Case study | Global | Energy and economy level data | Multi-country | Subsidies removal boost economic growth in the long run |
| Nepal and Jamasb (2012a) | Econometric | Transition economies | Panel data: 27 countries, 1990-2010 | Bias corrected fixed effects | Reform index has positive effect on GDP |
| Sen and Jamasb (2012) | Econometric | India | Panel data: 19 Indian states, 1991-2007 | Bias corrected fixed effects | Reforms positively affected the GDP |
| Carvalho et al. (2016) | Econometric | CIS and Non-CIS countries | Panel data: 25 transition countries 1992-2007 | Corrected LSDV | Reforms had positive effect on GDP index in CIS and Non-CIS countries |

3.2.3. Impacts of reforms on poverty alleviation

The literature on infrastructure reforms and the linkages to poverty shows that policy changes to improve the access and quality of infrastructure services help reduce poverty through direct and indirect channels, such as more opportunities to generate income, improving health and educational outcomes (Estache and Fay, 1995; Brenneman and Kerf, 2002). Hence, electricity reforms aimed at improving the access and supply reliability are expected to contribute to poverty reduction. However, the existing studies have not empirically examined the evidence. In fact, some studies examining this issue empirically (e.g., Victor, 2005) found no inherent connection between the energy markets reforms and welfare for the poorest households although energy consumption and economic growth are correlated.

The efficiency gains from privatization of energy utilities in Argentina accrued mostly to high-income classes, while the gains from effective regulation of newly privatized utilities accrued mainly to low-income classes (Chisari et al., 1999). All income groups benefited

from reforms while the distribution of income also improved (Navajas, 2000). In general, incidences of final electricity price reductions were experienced post reforms in Latin America although the price fall did not translate into increased affordability and access for the poor households. The electric utilities and the governments shared most of the gains in the form of rents and higher tax revenue (Estache and Rossi, 2004). In Peru, electricity consumers benefited the least from reforms as welfare gains were offset by price increases (Anaya, 2010). Nonetheless, the welfare consequences of gaining access to the electricity networks are high.

The extent to which electricity reform affects the poor primarily depends on the ability of reforms to enhance access. For example, energy poor also tend to be income poor as evidenced from India establishing a clear link between income poverty and energy poverty (Khandker et al., 2012a). Rural electrification also helped reduce poverty in India even though the larger share of benefits accrued to wealthier rural households (Khandker, et al., 2014). In addition, grid electrification in Bangladesh generated significant positive impacts on household income, expenditure and education where the household gain in total income due to electrification was around 21%, with a 1.5 percentage point reduction in poverty per year (Khandker et al., 2012b). Similarly, access to communal grid electricity generated externality benefits for the poor than the rich in Vietnam while access to household electricity benefited the rich than poor questioning the rural electrification's long term benefits for the overall rural economy (Khandker et al., 2013).

Some studies have examined distributional impacts of specific aspects of reforms, such as pricing reforms. Boccanfuso et al. (2009a) assess the distributional effects of pricing reform in Senegal. They found that increases in electricity prices bear little direct impact on most poor households as only few of them are connected to the network. Compensating measures such as cash transfers in the face of price increase slightly decreases income inequality between poor and rich households. Similar effects were observed regarding the distributional and poverty effects of price reform in Mali, a poor country in West Africa (Boccanfuso et al., 2009b). The increase in prices did not affect poverty directly as very few poor households are connected to the grid while households also reduce their electricity consumption when price rises. Unlike in Senegal, compensating measures such as cash transfer after the price rise did not help the low-income households losing from pricing reform. Based on the broad trends of energy reforms across the African countries, Clark et al. (2005) show that the impacts of reforms on the poor are neither direct nor inevitable.

Table 9: Reforms and Poverty Reduction

| Study | Approach | Region | Data | Method | Policy impacts and relevance |
|---------------------------|-------------|---------------|-------------------------------------------------|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| ADB (2005) | Case study | Asia | Macro-micro data | Multi-country | Strong links between investments in energy infrastructure and rural poverty reduction in Thailand and India |
| Betily et al. (2013) | Macro study | Ukraine | Household survey data for 2009 | CGE model | Increases in gas prices result in welfare losses across all households, with a more impact on urban households |
| Boccanfuso et al. (2009a) | Macro study | Senegal | Macro –micro variables between 1995 to 2001 | CGE model | Direct price effects are weaker than general equilibrium effects on poverty and inequality |
| Boccanfuso et al. (2009b) | Macro study | Mali | Macro –micro variables | CGE model | Direct price increases have minimal effect on poverty and inequality, whereas their general equilibrium effects are quite strong and negative |
| Clark et al. (2005) | Case study | Africa | Energy sector indicators, macro variables | Multi-country | Impacts of reforms on the poor are neither direct nor inevitable |
| Estache et al. (2002) | Case study | Latin America | Macro-micro variables | Multi-country | Evidence of reforms on poverty reduction is scarce; hence the analysis remain incomplete |
| Khandker et al. (2012a) | Econometric | India | Cross-section survey data for house-holds, 2005 | Probit estimates | Energy poverty and income poverty are directly linked to each other |
| Khandker et al. (2012b) | Econometric | Bangladesh | Cross-section survey data for households, 2005 | propensity score matching | Electrification led to household gains in income and poverty reduction |
| Khandker et al. (2012) | Econometric | India | Cross-section survey data for households, 2005 | maximum likelihood probit model | Rural electrification helped reduce poverty; larger share of benefits accrued to wealthier rural households |
| Solaymani et al. (2013) | Macro study | Malaysia | Time series macro and micro data | CGE model | Subsidy removal can potentially lead to significant falls in rural household incomes and rising poverty levels among rural households |
| Victor (2005) | Case study | Global | Energy sector indicators | Multi-country | Energy access and development correlated; link between reform and poverty reduction complex and non-inherent |

4. CRITICAL REFLECTIONS ON THE LITERATURE AND REFORMS

4.1. Evolution of the Reform Literature

The differences in the implementation and performance of reforms in developing and transition countries call for reflection on and taking stock of the experience in the span of more than quarter of a century and beyond the findings of individual countries and studies. The early reform trend was built on the principals of neoclassical economics, relying on competition for external efficiency and privatization for internal efficiency. It was inspired by a paradigm shift in the role of the state in infrastructure industries and public services as well as developments in industrial organisation and regulatory economics.

The initial view of the reforms was a fairly mechanical one meaning that the introduction of a specific set of steps would equate to successful implementation and scorecards could reflect and compare the progress of reform process (e.g., Bacon, 2001). For example, optimal sequencing of the reform steps also received some attention (IEA, 2000). Overall, reforms led to efficiency improvements (operational efficiency, labour productivity, etc.) as evidenced in the earlier studies. However, a combination of market and regulatory failure have meant the obtained efficiency gains did not automatically trickle down, as initially thought. This has created a chasm with the losers and has led to questioning the merits and motives of the reforms.

Attention was gradually directed at the role of regulation. Frequent renegotiations of contracts and concessions signalled that all was not well in the regulation front (Estache et al., 2003). The importance of regulation for fostering successful competition and privatisation in developing countries became the subject of both theoretical and empirical analysis (e.g., Laffont, 2005; Zhang et al., 2008). Moreover, most electricity networks in developing countries exhibited significant inefficiencies and required incentive regulation regimes. However, to date, apart from a number of efficiency and productivity studies, the empirical research on the effectiveness of incentive regulation of networks in developing countries has been limited.

Although the need for independent sector regulation was recognised from the outset, initially the importance of the wider formal and informal institutional context for effective functioning of the new authorities was not apparent. Gradually, the role of high level and sector level institutional norms and rules in the effectiveness of independent regulation to support the

reforms was recognised. Since the 2000s, a number of studies, have examined the institutional aspects of reforms on electricity sector performance and concluded that an effective institutional framework is a prerequisite for managing a reformed power sector. This led to the realization that much of the observed heterogeneity in the performance of reforms was due to the inability of the policy makers to properly understand and take into account the country specific context of reforms (Sen et al., 2016).

The ineffectiveness of the '*one size fits all*' approach to reforms was gradually and inevitably recognized. Also, in the light of the reform in Norway, privatization can now be perceived as an option rather than an integral part of the reform. It was also broadly recognised that electricity reform in developing and transition economies is closely linked with the country-specific political economy and institutional contexts.

4.2. Microeconomic Lessons from the Literature

The principal of cost-reflective pricing remains is central to well-functioning of market based reform models. Also in practice, reforms have generated pressure for revenue adequacy prompting the realignment of prices with underlying costs (Jamasp et al., 2005). Some reforms led to reduction in average wholesale prices to cost-reflective levels but not necessarily in the retail prices. Reforms led to cost-reflective pricing in some countries in Latin America and decreasing the price-cost margin across the industries and households. In a growing number of countries the policies of under-pricing and cross-subsidies are gradually being reversed post reforms.

The presence of an independent sector regulator and institutional quality seem to facilitate the transition to cost-reflective pricing and mitigate the adverse impacts of price increases by allowing some efficiency gains to be passed on to consumers (Estache and Rodriguez-Pardina, 1999). Hence, price adjustments can be undertaken prior to privatization to minimize the tension between economic efficiency and equity if privatization is considered an option. On the other hand, public opposition to rebalancing the tariffs in some developing countries underlines the need to design pricing policies that balances economic efficiency and social equity objectives.

In some developing countries, reforms have led to improved operational efficiency by minimizing energy losses and increasing capacity availability. For example, the liberalized market model in South America has been relatively successful in attracting investments in

generation than the dominant single-buyer model in South Asia (Millan, 2005). Reforms (mainly privatization and regulation) seem to have improved cost efficiency of utilities in many developing countries. In that sense, reforms seem to have fulfilled one of their major objectives. However, as mentioned, the gains have not trickled down to consumers. Evidence also suggests that consumers benefited from efficiency gains from privatization in the presence of effective regulation. Experience suggest the need to create an independent and competent regulatory body before privatization of electricity utilities.

The adoption of reforms in Latin America was accompanied with an expansion in rural electricity access programs as opposed to countries in South Asia and Sub-Saharan Africa where the lack of access to in rural areas remains a problem (Barnes, 2007). In contrast, South Africa achieved higher electrification without implementing the textbook reform model. Evidence suggests that, in the absence of other complementary socio-economic arrangements, reforms alone cannot significantly increase access to electricity in developing countries. The existence of subsidies for rural electrification programs has revealed the limits of the market based reforms to improve access to energy to the rural population.

Electricity theft remains a common problem in urban areas of many developing and transition countries despite the reforms. This implies that establishing social legitimacy of reforms is crucial in tackling the prevalent problems of non-technical energy losses (energy theft) and non-payment in developing countries. One way to increase the public acceptance of reforms and related policies by improving reliability of service, local engagement, and better communication with users.

As mentioned, pricing reform is a central part of electricity reforms. The studies of the price effects of reforms cover a range of different countries. However, despite their importance, these do not constitute a substantial literature. Many of these are multi-county studies which are difficult to conduct credibly due to the many differences such as the presence of various taxes and subsidies and currency exchange rate fluctuations. A measurement strategy in some studies has been to use the price ratios for different types of consumers. However, while the price studies may reveal trends and price changes among countries, they are of limited use for assessing reform performance in individual countries. Moreover, studies of price effects are primarily focused on the lower and middle income developing countries while studies of the poorest countries such as Eberhard et al. (2011) are scarce although this also reflects less reform activities in these countries.

There is a substantial and growing body of literature based on the efficiency and productivity techniques. Some of these also include some measures of quality and reliability of service in their models. The initiation of the reforms coincided with a period of strong methodological development and growing interest in the application of these techniques to empirical studies of network industries and in particular the electricity reforms. In the same period, some regulators adopted these techniques as practical tools for benchmarking of regulated utilities as part of their efforts to implement incentive-based regulation to promote cost efficiency in the natural monopoly networks. It is no coincidence that most efficiency and productivity studies of the sector are focused on the performance of electricity distribution utilities. The application of the techniques to sector-wide efficiency and productivity analysis have been, however, more difficult and, as a result, less common likely due to the unbundled structure of post reform sectors.

4.3. Macroeconomic and Welfare Lessons from the Literature

Reforms should ultimately improve human development and contribute to reduction in income inequalities. Reform success is often gauged against improved macroeconomic development and benefits to low-income groups through increased access, improved service, and affordable prices. The linkage between reforms and the poor is thus gaining attention considering the direct and indirect effects of reforms to the welfare of low income households. Our survey of the macroeconomic effects of reforms revealed only a limited number of studies based on cost benefit analysis, economic growth, and poverty alleviation. These studies are quite small in relation to the overall volume of the reform literature and are not of recent dates. This is somewhat unexpected as these topics constitute important motivations for reforms and aspects of their outcomes.

Few studies have used the CGE modelling approach. However, as with the reform and economic growth literature establishing causal effects between sector level reforms and its economy wide effects is inherently difficult. Cost benefit studies seem more suited for this task. The impact of reforms on economic growth is expected to be positive (Kirkpatrick, 2014). This is not surprising when macroeconomic conditions have catapulted energy reforms in many developing countries. Privatization, if pursued with economic motives, seems to be conducive in macroeconomic terms. However, removal of subsidies seems to generate contractionary economic effects in the short-run although the long-term effects are positive

(IMF, 2013). Hence, reform and rebalancing of energy subsidies in developing countries should be appropriately phased, well-targeted and transparent while the price increases should be sequential and not abrupt in order to support economic growth both in the short-term and in the long run.

Cost benefit analysis as an applied welfare economic tool is commonly used in most manners of policy analysis. However, we find that very few such studies have attempted to assess the performance of the reforms. Cost benefit analysis of policies often requires developing counterfactual scenarios of how the sector would have evolved without the reforms (see, Galal et al., 1994). Clearly, the counterfactuals would require some strong and limiting assumptions that would make the results of such studies uncertain. It is still surprising that so few studies exist while a cost benefit analysis of reforms in developing countries has important welfare motivations and effects.

Reforms can potentially enhance economic welfare as documented from the lessons of experience. However, reforms alone are incapable of creating an equitable distribution of welfare among different income groups. The welfare gains from privatization have mostly benefitted the domestic and foreign-owned producers. As indicated earlier, effective regulation increases the welfare gains for consumers. The importance of the regulatory framework in maintaining a balance between efficiency and equity considerations is paramount in developing countries.

Some poverty related reform studies are multi-country analysis. The insights gained by these have therefore limited relevance for the outcomes observed in individual countries. Also, the link between the reforms and poverty reduction is complex and difficult to quantify. However, evidence suggests the presence of a correlation between access to electricity and economic development (Sovacool, 2013). Better access to electricity in rural Bangladesh has increased the economic welfare of the poor and helped reduce poverty. This implies that reforms can aim at catering the electricity to the poor as part of efforts to reduce poverty. This is also a major challenge considering the costs involved. For example, the investment requirements for providing electricity to Sub-Saharan Africa over a 10-year period is estimated between 160 and 215 billion \$U.S. (Rosnes and Vennemo, 2012). Innovative market and incentive based models can improve the cost effectiveness of achieving access-enhancing targets.

4.4. Current State of the Literature

The empirical literature on the impacts of reforms represents a sizable research on this topic across both developing and transition economies. Most studies of reforms have analysed one or more of market structure, technical efficiency (e.g., reliability, environmental footprints), economic efficiency (e.g., reduction in supply costs and resulted electricity prices), impact of the reforms on broad economic variables (e.g., economic growth, social welfare). Latin America has received comparatively more studies for two reasons: (i) the region is among the pioneers of market-driven electricity reforms and (ii) the availability of data facilitating quantitative analysis of these reforms.

Overall, the evidence on the performance of reforms in developing countries remains mixed for varied reasons. The results indicate that reforms have not achieved the stated objectives in most countries. Moreover, the reform measures in the samples or case studies may be inadequate to identify significant effects using quantitative (mostly econometric) analysis. For example, adequate data is often not available to econometrically assess the impact of reforms on system reliability and service quality.

Electricity reform and performance data tend to suffer from endogeneity and simultaneity bias. Establishing the effects of reforms typically involve controlling for country or utility specific factors. This is because reforms are multi-dimensional and involve a number of simultaneous inter-related steps affected by a vector of political, economic and institutional factors that are difficult to quantify. These factors make it difficult to isolate the effects of specific reform steps or interactions among them on specific reform outcomes. However, econometric studies using similar methodologies and a narrow set of variables in different time periods have limited potential to make substantial contributions to the literature.

The main remaining challenges concern finding innovative ways to improve electrification, develop institutional capabilities, and align the reforms with sustainability objectives. The objectives of reforms are also undergoing a significant reorientation brought on by global efforts to reduce greenhouse gas emissions and combat climate change. The electricity sector accounts for the largest share of total emissions from the energy sector and driven by increases in developing economies, estimated at 40% (IEA, 2014). The debate in developing economies is therefore increasingly about how markets can deliver on emissions reduction targets and greener economic growth. Nonetheless, the emergence of market-based reforms

and renewable energy technologies has created opportunities to jointly achieve the access and sustainably objectives.

The reallocation of subsidies towards the renewables and reducing fossil fuel subsidies given that they are poorly targeted and bear large environmental costs is increasingly an option. Future research should build on the existing knowledge to address the new challenges facing the sector and reforms. Recent studies such as Carvalho et al. (2016) and Sen et al. (2016) have started the empirical debate. However, designing all-encompassing reforms capable of dynamically balancing economic efficiency, welfare (human and economic well-being) of the poor, and affordable energy in developing and transition economies remains arguably the main strategic challenge facing the reforms.

5. CONCLUSIONS

This paper reviewed the literature on the linkages between electricity reforms; economic and technical efficiency, operational performance, economic growth, economic welfare and poverty reduction in developing countries. This was conducted in the context and motivation of energy reforms, reviewing the progress and assessing the factors that shaped the outcomes of reforms, measuring reform performance, exploring the theory and practice of electricity reforms and critically formulating policy lessons based on the performance of reforms in developing countries. The extent of reforms varies across the developing countries in terms of changes in market structures, the role of the state and the regulation of the sector.

The literature suggests that assessments reforms have mainly focussed on measuring their operational and economic efficiency and productivity impacts. However, the literature on the macro linkages of the reforms is scarce. Also, research on the impact of reforms on the poor remains limited. Hence, examining the impact of reforms on factors directly affecting the poor needs to be among future topics for research. Moreover, the incompleteness of reforms and the interplay of economic, political and institutional compounds the challenge of properly measuring the impacts of individual reform steps.

Reforms have improved the efficiency and productivity in the sector, although the efficiency gains have not always reached the consumers. The establishment of effective independent regulation is necessary for the transfer of efficiency gains to the customers and ensure that

not only producers and the government benefit from privatization. Reforms can help poverty alleviation when the poor have access to electricity. This implies that reforms should be localized with a view to meet the electricity needs of the poor. There is also consensus in the literature that the regulatory framework is crucial for balancing the tension between economic efficiency and equity impacts of reforms.

We found several caveats in the literature, which future research can address. Cost-benefit analysis of reforms remains limited. The impact of reforms on electricity network investments, reliability, and cost effectiveness are unclear and under-studied. Competition in the wholesale markets and diagnosis and mitigation of market power in developing countries also need to be studied in the aftermath of reforms although it is desirable to deal with market power structurally *ex ante*. The empirical literature focuses mostly on the electricity sector. Similar studies should explore the impacts of reforms in other energy sectors and related liberalized network industries.

Moreover, there is a large number of small systems in developing countries and these require reform models and solutions that differ from those of large systems. Also, the lack of institutional capacity and expertise tends to be exacerbated in small developing economies. However, the literature on reform in these sectors remains rather limited partly due to the fact that reforming these systems have been more difficult.

Finally, research should address the emerging challenges facing the sector and reforms such as the reallocation of subsidies from fossil fuels towards the renewables. Also, reforms increasingly need to balance the need for competitive markets with intervention to accommodate renewables and climate change policies. Designing all-encompassing reforms capable of dynamically balancing economic efficiency, welfare (human and economic well-being) of the poor, and affordable energy is arguably the main strategic challenge facing the reforms. Therefore, research also needs to evolve and consider multi-dimensional assessments of the reforms.

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